

# Coupled atmosphere-ocean model SLAV-INMIO: implementation and first results of verification

R.Yu. Fadeev<sup>1,2,3</sup>, K.V. Ushakov<sup>4,1,2</sup>, M.A. Tolstykh<sup>1,2,3</sup>, R.A. Ibrayev<sup>1,2,3,4</sup>

(1) G. I. Marchuk Institute of Numerical Mathematics, Russian Academy of Sciences

(2) Hydrometeorological Research Centre of Russia

(3) Moscow Institute of Physics and Technology (State University)

(4) Shirshov Institute of Oceanology, Russian Academy of Sciences

SLAV-INMIO [1] is an original coupled atmosphere-ocean model developed in Institute of Numerical Mathematics (INM RAS), Shirshov Institute of Oceanology (IO RAS) and Hydrometcentre of Russia (HMCR). This model incorporates the global atmosphere model SLAV (horizontal resolution  $0.9^\circ \times 0.72^\circ$  and 28 vertical levels) [2,3], the World Ocean model INMIO ( $0.5^\circ$  and 49 vertical levels) [4] and the coupled model framework CMF2.0 that synchronize the components, transfer data between them and works with file system. It should be noted that SLAV model is a component of the probabilistic long-range weather forecast system in HMCR. This model is also applied for the operational medium-range weather forecasts with the lead time up to 10 days at HMCR.

The SLAV-INMIO coupled model is verified with series of numerical experiments with the integration time up to several years. The model annually averaged surface heat flux is in qualitative and quantitative agreement with the reanalysis data (ERA2). Average annual mean values of short and long-wave radiation, the latent and sensible heat fluxes at the surface are in the range recommended by Intergovernmental panel on climate change (IPCC). The overall heat balance at the surface is close to zero. To achieve those results, we had to implement multi-layer soil model and a number of other parameterizations into SLAV model jointly with overall tuning of the model. The obtained results form the basis for further application of this coupled model to the problem of long-range weather forecast. It is planned to verify SLAV-INMIO coupled model with the standard numerical experiments on Earth climate change modeling according to the international CMIP program.

This work was supported by the Russian Science Foundation grants No. 14-27-00126.

## References

- [1] R. Fadeev, K. Ushakov, V. Kalmykov, M. Tolstykh, R. Ibrayev *Coupled atmosphere–ocean model SLAV–INMIO: implementation and first results* // Russ. J. Numer. Anal. Math. Model, 2016, vol.31, No.6, P. 329–337.
- [2] Tolstykh et al. *Development of the multiscale version of the SL-AV global atmosphere model* // Rus. Meteor and Hydrol., 2015, V. 40, N 6, P. 374–382.
- [3] M. Tolstykh, *Variable resolution global semi-Lagrangian atmospheric model* // Russ. J. Numer. Anal. Math. Model, 2003, No 18, P. 347–361, <http://dx.doi.org/10.1515/156939803769210993>.
- [4] R. Ibrayev, K. Ushakov, R. Khabeev *Eddy-resolving  $1/10^\circ$  model of the World Ocean* // Izvestiya. Atmospheric and Oceanic Physics. 2012. V. 48. N 1. P. 37–46.